Earth and Planetary Science Letters, 96 (1990) 443–457
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

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Late Pleistocene geomagnetic excursion in Icelandic lavas: confirmation of the Laschamp excursion

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Received March 5, 1989; revised version received September 20, 1989

In 1980 Kristjansson and Gudmundsson [1] reported a late glacial geomagnetic excursion in three hills in the Reykjanes peninsula, Iceland, with shallow negative inclinations and westerly declinations. They named it the Skalamaelifell excursion. More extensive field work has identified the same excursional paleomagnetic direction (declination = 258°, inclination = −15°) at four additional outcrops in a 10 × 10 km area in the Reykjanes peninsula. The excursion lavas are olivine tholeiites with similar petrography and chemical compositions. Paleointensity determinations by the Thellier method average 4.2 ± 0.2 μT for 8 samples, more than an order of magnitude weaker than the present geomagnetic field in Iceland. Together, these results suggest extrusion of the excursion lavas in a very brief span of time, probably less than a few hundred years.

K-Ar dating of the excursion lavas gives a mean age for 19 determinations of 42.9 ± 7.8 ka (2σ). Compilation of thirty K-Ar ages of the Laschamp and Olby flows by three laboratories yield a new age for the Laschamp excursion in France of 46.6 ± 2.4 ka (2σ). The age of the excursion in southwestern Iceland is statistically indistinguishable from the Laschamp excursion at the 95% confidence level, and both have very low paleointensities. Therefore, we suggest that the Laschamp and Olby flows in France and the Skalamaelifell units of Iceland recorded essentially the same geomagnetic excursion. Differences in the virtual paleomagnetic poles (VGPs) of these excursions may be due to (1) the probable non-dipole character of the geomagnetic field during the excursion, (2) rapid geomagnetic secular variation and possible small age differences of the extrusive rocks in France and Iceland, and/or (3) crustal magnetic anomalies which might dominate the local geomagnetic field during the excursion at either or both locations.

1. Introduction

Geomagnetic polarity time scales for the last few million years [2,3] show the Brunhes normal polarity chron of the past 0.72 million years (m.y.) to be 2–3 times longer than the average length of polarity intervals for the last 40 m.y. [4]. However, evidence has been accumulating for the existence in the Brunhes of several short-lived polarity reversals or excursions, including Big Lost at about 0.6 Ma [5], the Emperor at about 0.5 Ma [5–7], and the Blake at about 0.11 Ma [5,8–11].

In the most recent 0.1 m.y. several possible paleomagnetic excursions have been detected, including the Mono Lake excursion from 26,000 to 29,000 years before present (ka) [12–14], the Lake Mungo excursion at 30–32 ka [15,16], an excursion at circa 17 ka [17–19], and the Laschamp excursion between 40 and 50 ka [20–23]. Of these excursions only the Laschamp has been identified in igneous rocks.

Geomagnetic reversals and excursions preserved in sedimentary and igneous sequences can be valuable for stratigraphic correlations, especially for the Neogene. In addition, detailed studies of the geomagnetic field for the Brunhes chron, for which high-resolution records are more readily available, are important for understanding the full spectrum of geomagnetic behavior.

The paleomagnetic direction of the Laschamp and Olby units in the Massif Central in France can be considered to have reversed polarity. However, recent measurements [24] have shown that the flows recorded a very low paleointensity (less

0012-821X/90/$03.50